Seven Digital Steps to Avoid Utter Hell

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Human civilization faces dramatic challenges that digital technology can help to resolve.

In the July 2010 essay for this column's tenth anniversary, I explored how the computing profession might prosper institutionally, a topic central to this column and the IEEE Computer Society's planning. As a follow-up I wanted to look at where the profession's technology might be made useful, reviewing some of the technical suggestions I've made here over the years.

One idea was to echo my second anniversary essay, "Seven Great Blunders of the Computing World" (July 2002, pp. 110–112), which sought to counter the commonly held belief that the computing profession had brought about an ideal digital world. However, to take a more positive stance, I thought to call this essay "Seven Digital Steps Toward Earthly Paradise."

PARADISE LOST?

The psychological problem thus created was to think there was any possibility of anything like paradise happening on this planet in the foreseeable future. The opposite seems certain.

Five years ago I wrote "The Profession and the Big Picture" (Feb. 2005, pp. 102–105), an essay based on what seemed then to be the highly probable prospect of adverse climate change, which the world seemed to be waking up to and that governments seemed committed to tackle.

The waking up and tackling hasn't happened. Climategate was one event that seemed to allow inaction, but climate change science has since been confirmed, not refuted (tinyurl.com/257lsvc). Even the allegedly baseless claim of Himalayan glacial retreat has been validated (tinyurl.com/323jykz).

Here in Australia, one of the world's worst per capita polluters (and that's without counting massive coal exports as emissions), we are now in the midst of a federal election campaign in which "both major parties are missing in action on climate" (tinyurl.com/2ce496r). Things don't seem much better in other parts of the world. The emissions of our dark satanic mills, power stations, and cars and planes are greatly worsening our climate and living conditions, gradually but maybe irretrievably.

The barriers to needed mitigation and adaptation are much more generally social than merely political (tinyurl.com/2d5mcf5). The difficulty is that the barriers must be removed quickly, and this can only be done through focused education. Here digital technology could greatly help in a reformed and refocused education system through, for example, measures suggested in this column (Mar. 2008, pp. 102–104). But even this would be far too slow. Formal education is traditionally an institution for childhood because the mind, once formed, is taken to be fixed for life. So the effects of improved education would take generations to be significant. All this strongly suggests a hellish future, if not doom, for human civilization.

A GLIMMER OF HOPE

Adventitiously, my thinking was given a prod by a Canadian television documentary, "The Brain That Changes Itself" (tinyurl.com/6muvq8). Based on a splendid book of the same title by researcher Norman Doidge, it shows dramatically the reality and wonder of neuroplasticity—that is, the ability of the brain to have its functioning reconfigured and restored by appropriate experience.

The first chapter in the book starts by describing a woman who had completely lost her sense of balance. For five years she had led a hopeless life. She was cured by being fitted from time to time with a helmet of accelerometers that fed signals to her tongue through a pad of electrodes. This immediately gave her back her sense of balance, a restoration that persisted for a while after the helmet was taken off. A year or so later, the helmet was no longer needed. Her brain had been persuaded to rewire itself.

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The documentary and the book describe many other examples of neuroplasticity in both the young and old. Often the use of digital technology is significant, both in diagnosis and treatment.

Neuroplasticity in the young is the basis for our conventional education system, and for whatever culture we acquire in our youth. The benefit of rehabilitating young criminals by applied neuroplasticity is surely obvious. In some countries it is already being done in a small way.

Successfully adapting to the effects of climate change will require dramatic cultural change. What has been found out about neuroplasticity suggests that such cultural change is possible because the culture of adults can be changed. Techniques for bypassing deeply embedded perceptual and behavioral reflexes have been demonstrated to work.

All this suggests that there is indeed a hope, albeit slim, that human civilization might survive the trauma of a vastly more challenging physical world than the present. For this hope to be realized greatly enhanced technology will be needed, and the role of digital technology will be central.

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THE SEVEN STEPS

Digital technology is highly significant in its potential for promoting culture change. We need change because our present culture is developing along lines that concentrate on the present and the individual. This is not what we need to deal with climate change, or even to realize that a huge challenge exists before it's too late.

In developed countries like Australia, literacy and numeracy have long been declining and social problems such as family instability have been increasing. But the difficulties we face need much greater social coherence and technical understanding. This can only be brought about by greatly improved and extended education.

Digital technology has enormous, largely untapped potential to help teachers achieve this, but the teachers need the computing profession's support. The following seven steps offer a promising start.

Arithmetic

The basis of numeracy is the number system. The digital processors and the programs we have at present perpetuate the compromises that were made long ago in adapting the technology of the time to the arithmetic needs of professional end users.

For support of everyday numeracy, computers should deal with a variety of numbers seamlessly and produce results that are exact if possible or as precise as feasible otherwise. For example, nondecimal fractions must be entered exactly, and combined exactly with other exact numbers, at least up to multiplication and division.

I've already looked at some of these possibilities in the Feb. 2003 issue, pp. 106–108, and in the Mar. 1997 issue, pp. 65–73.

Text

Human cultures have developed a variety of ways to render their spoken languages as text, and many writing systems have been adapted to represent various spoken languages. The system used here—based on the Roman alphabet—has spread worldwide, and in the process adopted a great variety of embellishments to suit it to different languages.

Such embellishments added a richness and expressiveness to text, for example, allowing scansion and stress to be shown (or tone in Vietnamese), and allowing this expressiveness to be passed across languages. Thus, in English we could borrow words like élite and façade, and names and titles like Chloë and Señor, and know how to pronounce them.

Tragically, in the early days of digital computers, the character set was drastically simplified in both what could be keyed in and what could be printed out. Nowadays, all the old expressiveness and much more could be provided, but the technology doesn't do it. For instance, the only accents on the EBCDIC keyboards are ` ~ and ^ and even they can't be used as accents at the ordinary user's discretion. The only software I know of that allows general use of accents is Donald Knuth's TEX (*The TEXbook*, Addison Wesley, 1986, p. 52).

To support the joy of using text, especially in education, each writing system should be fully supported in its keyboard, printing, and searching. Some aspects of this have been considered in this column: Aug. 2006, pp. 102–104; June 2003, pp. 114–116, and Sept. 2007, pp. 110–112; and also in *Computer*, Aug. 1998, pp.108–109; and eprints.utas.edu.au/1564.

Algebra

Once we clean the handling of individual numbers, we can turn to the software that processes them for ordinary users. This has two aspects.

Handling numbers singly is of relatively little use in many areas. Lists and tables abound in ordinary life, as in technical work. Also, different kinds of numbers—exact and inexact, integral and fractional, real and complex, even sets and intervals—must coexist peacefully in lists and have their properties affect any computed results they lead to.

Applying arithmetic functions one at a time is tedious in all but simple computations. The ordinary user must be able to construct and save formulas as lists and combinations of other functions to do, in effect, simple algebra.

I outlined a design for such a device or program, called a *formulator*, in this column in November 2009 (pp. 106–108).

Vocabulary

Words form the basis for social communication. When two or more people interact socially or professionally, verbally or textually, the more words they have in common, the richer and more effective their interaction can be.

Vocabularies are enlarged by drill and practice, a procedure that promotes neuroplasticity and employs both images for reading and recognizing, and sounds for hearing and speaking. Writing and keying could also be involved.

Done by software, vocabulary could be greatly enlarged for young and old in speeds and directions dependent on the learner's whims and talents. For the young, parents and teachers must keep an eye on progress and affect direction. Some important suggestions in this area were outlined here (March 2008, pp. 102–104).

Rationality

In real life, calculation has a purpose. It helps choose the best decisions in quantitative circumstances. Making such decisions joins logical analysis and reasoning to calculation. Adapting to climate change will require wholesale decision making.

Logical principles can be taught by drill and practice, particularly when they involve measurement or estimation. But decision making is primarily a social activity because significant decisions usually involve people other than the decision maker. Education in decision making must be with, or at least about, people interacting. Computer-based academic games do such education well (Nov. 2005, pp. 106–108).

Some 40 years or so ago, I was involved with computer-based management games and was impressed with their success and fascinated by the potential for academic gaming. Attendance at an international conference in November 2005 heightened my fascination. This conference was run by the Society for the Advancement of Games and Simulation in Education and Training (sagset.org), an organization that deserves the strongest support from the computing profession, but hasn't yet got it.

Grammar

Vocabulary provides the basis for communication, but grammar governs the use of vocabulary in the interest of reducing misunderstanding. For an international language like English, knowledge of grammar is especially important.

In some countries teachers do not enforce good grammar but encourage individual expression on the grounds that this is better for students' self-esteem. This is a tragic mistake (tinyurl.com/26z7le6).

Individuals can use software to acquire the basics of good grammar, but this must be reinforced and extended by group activities. Computer-based academic gaming could be used for this, as could teleconferencing.

Sociality

Sociality is where technology moves back a little, because it must come primarily from personal interactions. It's still the product of neuroplasticity, and Doigt's book has a fascinating appendix on the topic: "The Culturally Modified Brain."

Digital technology can still be used to support personal interaction in many different ways, with teleconferencing just one example. However, computer-based support for developing musical skills to be used in group performances, choral and instrumental, is of great significance (Sept. 2009, pp. 102–104). Thus, in the context of eventual international cooperation in adapting to climate change, I am saddened to report that Iran's supreme leader has announced that "promoting and teaching [music] is not compatible with the highest values of the sacred regime of the Islamic republic" (tinyurl.com/2fm2rjj).

The computing profession has an opportunity and a duty to support the practical exploitation of neuroplasticity by, for example, taking the seven steps I've described. The effectiveness of the technique will greatly depend on applying digital technology well, and this effectiveness can be demonstrated by its use in both early and rehabilitative education of various kinds.

The very high probability, if not certainty, of worldwide procrastination over climate change control will mean hell on Earth within a matter of decades. We must thus use technology to help us adapt to completely different living conditions.

As for the accompanying social turmoil, that will make the present problems of the Middle East and other global hotspots look trivial, to put the matter lightly. The only possible amelioration will be global cultural rehabilitation. For this to have any possibility of success, neuroplastic education must be applied globally. The computing profession must work with government and with other professions, especially the teaching profession, to ensure that effective techniques for this education are developed well before they are needed.

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